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Such a formula would indicate to the examiner that X is especially deficient or peculiar in affective characteristics.

6. The measuring scale shall be arranged on four pages, those measurements dealing with one of the four categories of mentality occupying a page. On each sheet, the several measurements shall be arranged in order of increasing difficulty, and the same shall hold of the order of arrangement within any given part of the series, that is, any one of the twenty types of measurement.

7. The measurements shall be chosen, so far as possible, with a view to simplicity of materials and ease and uniformity of observation.

8. The scale shall be dependent for its value upon safely determined norms.

COLOR VISION IN THE RING-DOVE (Tutur risorius)

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The psychophysiological literature, both naturalistic and experiental, on color vision in infra-human animals, is surprisingly extensive. But even more surprising is the extreme uncriticalness of the methods which have been employed. A realization of this condition of affairs within the past decade led simultaneously to the development, by C. Hess, in Europe, and by R. M. Yerkes in association with J. B. Watson, and more recently by G. H. Parker, in America, of spectral methods for the comparative study of color vision. These methods enable the experimenter to measure and control his stimuli in their various aspects and to observe with reasonable accuracy organic response to specific stimuli. The method now in use in this country, developed by Watson and me, may be named from the nature of the stimulus and the form of reaction demanded 'the method of discriminating spectral stimuli.' It involves the use of a special form of prism spectrometer with devices for selecting, spacing, reversing, and displaying any two portions of the spectrum, with means of controlling the selected stimuli qualitatively and intensively, of measuring them in photometric and energy units, and of so presenting them to the reacting animal that it may, if capable of so doing, recognize them and react appropriately.[1]

Until very recently, it has been the prevalent opinion even among scientific persons that many, if not most of the vertebrates, possess fairly highly developed color vision, which in many instances is closely similar to the human. That this opinion is erroneous and demands correction is proved by the results obtained by the use of spectral stimuli. It is now definitely known, for example, that, among the rodents, the mouse, rat, and rabbit well-nigh lack the ability to distinguish colors. For them, long wave-lengths are of surprisingly low stimulating value. The spectral range of certain day-birds appears to be similar to that of man. Among the higher animals, critical observation indicates that the cat and dog possess slight power to respond differentially to different wave-lengths. The observations at present available do not justify dogmatic statements, but they conclusively prove that all earlier accounts of color vision in these animals are misleading.

During the past ten years, I have devoted a large amount of time to the development of methods and the accumulation of facts. My study of vision in the dancing mouse,[2] which went far toward proving the absence of color discrimination in that organism, led me to abandon the use of stimuli obtained from colored papers, cloths, or the use of ray-filters, and to depend wholly upon spectral light.

At present I have undertaken the study of color vision in the ring-dove,[3] using the Watson-Yerkes spectral light apparatus with a type of reaction-box which was developed in connection with the study of the dancing mouse. The method which is employed in connection with this apparatus has been called 'the discrimination method.' Watson has recently suggested the name 'sensory habit method.' It involves the simultaneous presentation to an organism of two stimuli which differ definitely and measurably in some respect or respects. It demands of the animal that it react differently to the two stimuli; to the one of them positively, to the other negatively. Positive reaction is encouraged by the reward of food and inappropriate response is discouraged by disagreeable electrical stimulation. The essential features of the apparatus are, first, a home compartment in which the animal receives stimulation from two adjacent sources. If, in a certain required manner, it approaches the stimulus which has been defined as the 'positive,' it is permitted to escape thence by way of a narrow passage to a food compartment where it receives its reward. If, on the contrary, it approaches the stimulus designated as the 'negative,' it is punished by electrical stimulation, is forced to retreat, and then again has the opportunity to react to the 'positive' stimulus.

The sensory habit apparatus, even in its most improved form, is a fairly simple mechanism, and the sensory habit method, with the employment of reward and punishment as conditions for careful discrimination and habit formation, has proved remarkably satisfactory and has yielded valuable results in numerous investigations.

It has thus far been demonstrated that the ring-dove may be trained, although rather laboriously, to appropriate forms of achromatic discrimination, and that similarly it may be used by the sensory habit method for studies of chromatic discrimination. Experiments with two individuals demonstrate the existence of the Purkinje phenomenon in this organism. This was done by use of a red of 630 $\mu\mu$ and green of 505 $\mu\mu$, approximately equal in energy. In general illumination, the two stimuli seemed to be of approximately equal stimulating value for the female, whereas for the male, the red was the more stimulating. A moderate degree of adaptation to darkness reversed this relation, the green then being much more stimulating than the red for the female, whereas the two were approximately equal for the male.

This observation indicates at once changing sensitiveness with adaptation and an individual, or more likely, a sex, difference in the stimulating value of the colors in question. Apparently the male ring-dove is markedly more sensitive to red than is the female.

This report of work which is still in progress may be concluded with a word concerning the significance of temperamental differences. In the doves in question, these were very striking indeed and are responsible for certain important features of the results obtained. The female was tame and timid; the male, on the contrary, somewhat wild and bold. In view of these facts, it is not surprising that the male proved an excellent subject for the sensory habit method, whereas the female was much less satisfactory. The suggestion from the work is that temperament should be analyzed by the student of animal behavior and its various important components separately studied and accurately measured so that our animal subjects may be described with respect to the same, even although the investigation especially in point be one on color vision or some other aspect of reaction or experience which might at first seem unrelated to 'temperament.'

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[1] See Yerkes, Robert M. and Watson, John B. Methods of studying vision in animals. *Behavior Monographs*, vol. 1, no. 2. (1911).

[2] Robert M. Yerkes. *The dancing mouse.* New York, 1907.

[3] This work was made possible by a grant from the Bache Fund of the National Academy, for which the writer takes this opportunity to express his hearty thanks.